

# **LabSim Simulation Software User Manual**

**Rev. 2**

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**Prepared for:  
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## TABLE OF CONTENTS

<b>1</b>	<b>INTRODUCTION .....</b>	<b>3</b>
1.1	Identification.....	3
1.2	System Overview .....	3
1.3	Document Overview.....	3
<b>2</b>	<b>PREREQUISITES AND INSTALLATION.....</b>	<b>4</b>
2.1	Hardware Requirements .....	4
2.2	Software Requirement .....	4
2.3	Files Included in Release.....	4
	<b>Configuration.....</b>	<b>5</b>
2.3.1	Site Layout Creator .....	5
2.3.2	SpatialSim .....	6
2.3.3	SocialSim .....	7
2.3.4	SimDIS.....	8
2.4	LabSim Run Procedures.....	9
2.4.1	Site Layout Creator .....	9
2.4.2	SpatialSim .....	9
2.4.3	SocialSim .....	9
2.4.4	SimDIS.....	9
<b>3</b>	<b>TROUBLESHOOTING NOTES .....</b>	<b>10</b>
3.1	Site Layout Creator.....	10
3.2	SpatialSim .....	10
3.2.1	Missing SpatialSim XML Scenario Input File .....	10
3.2.2	Improper Scenario Input.....	10
<b>4</b>	<b>APPENDIX .....</b>	<b>10</b>
4.1	Scenario Input File.....	10

# 1 Introduction

## 1.1 Identification

This Software User Manual is for the BAE Systems LabSim simulation system and its supporting technologies. It describes the delivered executable code that was provided along with the final report on April 30, 2006 to US Navy, Office of Naval Research.

## 1.2 System Overview

The objective of the LabSim is to develop an instantiation of a modeling and simulation (M&S) framework for Force Protection Laboratory (FPL). This M&S framework will provide an environment to study the following aspects of force protection for the base:

- Sensor systems effectiveness
- Intelligent placement of sensors for anomaly detection
- Behavior analysis of vehicular and pedestrian traffic
- Social complexity modeling of the local and greater communities around the base.

While LabSim is a delivered application, it is still a prototype that attempts to address ONR objectives in the Phase 1 process.

LabSim consists of four main subcomponents. These components function as separate applications. Table 1 provides a brief description of each component.

**Table 1: LabSim components**

LabSim Component	Description
Security Layout Creator	Graphical tool to place sensors, facility, and site specific parameters to develop inputs for the spatial simulation
SpatialSim	C/C++ base run-time spatial simulation engine
SocialSim	Java-based social simulation engine
SimDIS	Naval Research Laboratory GOTS 3D Visualization tool

Currently, LabSim components can not interoperate. Data output from one component must be assigned as arguments to the next simulation component in a specific input format. This document outlines the process and usage of the components to perform a simulation exercise and to assist in the analysis of the output results.

## 1.3 Document Overview

The document is arranged into three main sections. Section 2 provides a description of the prerequisites and installation procedures. Section 3 describes the procedures for running each of the LabSim components, and a description of the outputs generated by each subcomponent. Section 4 includes notes on troubleshooting common errors.

## 2 Prerequisites and Installation

### 2.1 Hardware Requirements

The LabSim system must be executed on an Intel-base processor with a minimum of 2 GB of RAM. The simulation system has been tested with an ATI Radeon Mobility 9000 graphics card with 32 MB video cache.

### 2.2 Software Requirement

The LabSim system is comprised of various open source, COTS, and GOTS software libraries and tools. In theory all of the subcomponents can be hosted on a Unix system but has not been tested outside of the Windows XP environment. The C/C++ run-time spatial simulation must run in a cygwin 5.1 environment. If this environment is not available, the necessary Windows dynamic link libraries (DLL) are provided on the deployed CD. The Site Layout Creator component assumes familiarity with ESRI ArcView ArcMap application. Table 2 outlines the list of required libraries and supporting applications.

**Table 2: LabSim subcomponent software requirements**

LabSim subcomponent	Version	Description	App.	Lib.
Security Layout Creator				
ArcView	9.1	ESRI ArcView GIS editor application	X	
SpatialSim				
Cygwin	5.1	Unix environment emulator for Windows	X	
Boost	1.33	Open-source C/C++ template libraries for time, matrix, random number generation		X
Xerces-C	2.7	XML DOM parser library		X
Shapelib	1.2	Library for reading ESRI shapefile format		X
SocialSim				
Java JRE	1.5.0.1	Sun Java Virtual Machine	X	
POI	2.5.1	Apache Foundation java library for reading and writing Microsoft Excel Spreadsheet		X
SimDIS	8.0			
		See: <a href="https://simdis.nrl.navy.mil/">https://simdis.nrl.navy.mil/</a>	X	

### 2.3 Files Included in Release

The prototype release provides only the supporting libraries and executes code. Table 3 provides a summary of the files required by each subcomponent.

**Table 3: File released**

Files released name	Directory	Description
Security Layout Creator		
pmrf.mxd	./data/gis	ESRI map file – contains a site specific scenario
facility_layout.shp	./data/gis/facility_layout	Shapefile for describing the facilities at the base

guard_route.shp	./data/gis/guard_route	Shapefiles for describing the various routes of the guards
road_network	./data/gis/road_network	Shapefiles for describing the various routes of each of the designate entity classes
sensor_layout	./data/gis/sensor_layout	Shapefiles contain various sample layouts of sensors at the base
site_boundary	./data/gis/site_boundary	Shapefile to describe the physical boundary of the base
Base_North.tif	<a href="http://www.soest.hawaii.edu/coasts/data/kauai/pdcimagery">http://www.soest.hawaii.edu/coasts/data/kauai/pdcimagery</a>	Geotiff 1 meter resolution imagery data
Base_South.tif	<a href="http://www.soest.hawaii.edu/coasts/data/kauai/pdcimagery">http://www.soest.hawaii.edu/coasts/data/kauai/pdcimagery</a>	Geotiff 1 meter resolution imagery data
SpatialSim		
pmrf_sim.xml	./data	Scenario input file for spatial simulation
sensor_param.xml	./data	Sensor parameter file contains all sensor models for the spatial simulation
pmrsim.exe	./bin	Spatial simulation executable
cygxml-depdom27.dll	./bin	Xerces XML Parser Cygwin DLL
cygxml-c27.dll	./bin	Xerces XML Parser Cygwin DLL
cygwin1.dll	./bin	Cygwin DLL

## Configuration

### 2.3.1 Site Layout Creator

In this version of Site Layout Creator no customization of ArcView 9.1 were made. To configure Site Layout Creator, the pmrf.mxd mapfile needs to be loaded into ArcView ArcMap application. Upon loading pmrf.mxd map file, the ArcMap application will be configured with the appropriate imagery and vector files as shown in Figure 1. The left hand side Table of Content View shows the layers that have been created and are available for viewing and user customization. The checkbox next to each item toggles their visibility on the right hand side Data View screen. User can modify a road network by selecting the Editor tool on the toolbar. Similar actions can be taken to change the sensor layout layer and the site layer.

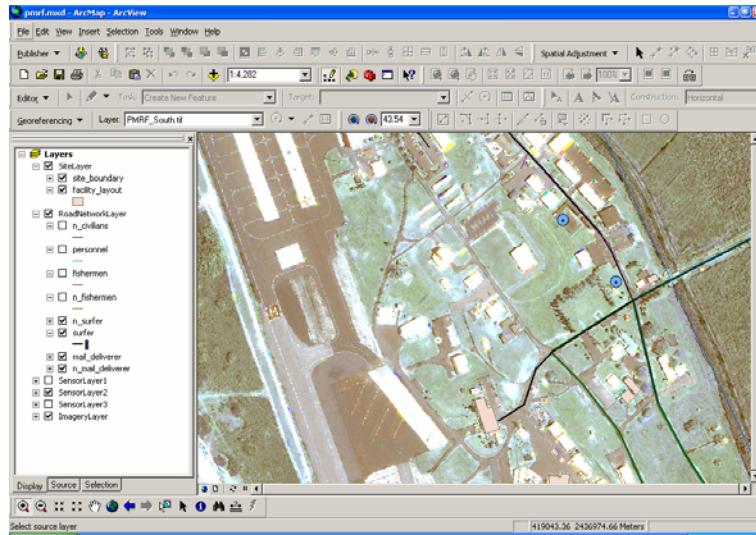


Figure 1: Site Layout Creator screen shot

### 2.3.2 SpatialSim

All configuration of the spatial simulation must be performed through the pmrf\_sim.xml scenario input file (See Section 4). This section describes the XML elements of the scenario input. Please note that all time specification is in seconds.

Element	Description
<b>input_parameter</b>	Contains all global data shared by entities with the spatial simulation.
scenario_name	Unique name for a simulation run.
classification	INFOSEC classification: UNCLASSIFIED, SECRET, TOP SECRET.
ref_date	Reference year for the simulation to start
coordinate_system	Specify the coordinate system currently only support Latitude, Longitude, and Altitude (LLA), Earth Centered Earth Fixed (ECEF).
simulation_seed	Specify a simulation random number seed for the entire spatial simulation system. Use 0 (zero) to force the simulation to use the system time as a random number seed.
gis_data	Specify the vector data files used by the simulation.
simdis_output	Specify the location and filename of the SimDIS output file.
agent_sim_output	Specify the location and filename of the social interaction file.
fusion_output	Specify the location and filename of the fusion metric file.
simulation_seed_file	Specify the location and filename of the simulation seed outputfile.
<b>entity_list</b>	Contains description of the entities that will participate in the simulation.
sensor_units	Specify the location of the sensor parameter input file, and which sensor layout to use. As far as the spatial simulation is concerned a sensor unit is an entity.
visitor_units	Specify the population type, class and size that will be generated in the spatial simulation. The population type is a generic identifier to divide the population into broad categories of local or tourist. The population class specifically identifies the entities to being one of the following classes {surfer, beach goer, mail deliverer, fisher men, navy personnel, navy civilian}. Each class has a unique road_network path, simdis property and visit time. The road_network is specified as a map_layer.
guard_units	Specify the population of the guards on the base the road_network path, and work shift. The road_network is specified as a map_layer.

<b>anomaly_detector</b>	Contains descriptions of the normalcy data for each class of the entities participating in the simulation.
normalcy_data	Specify the class and associate road_network path.
<b>data_mgr</b>	
classes	Specify the location of the classes.xml file that is used by the spatial simulation to determine the unique handle id of internal classes.
<b>time_mgr</b>	
Start_time	Specify the start time of the entire spatial simulation in seconds.
End_time	Specify the stop time of the entire spatial simulation in seconds.

### 2.3.3 SocialSim

The SocialSim can be configured through the SocialSim GUI. As shown in Figure 2 the GUI has three tab panes for Simulation, Experiment, and Data. The user can configure the input for the agents in the simulation tab. The agent populations that can be configured are: Number of Guards, Number of Locals persons, and Number of Tourists. The agent character traits are persuasiveness, reasonableness, and popularity.

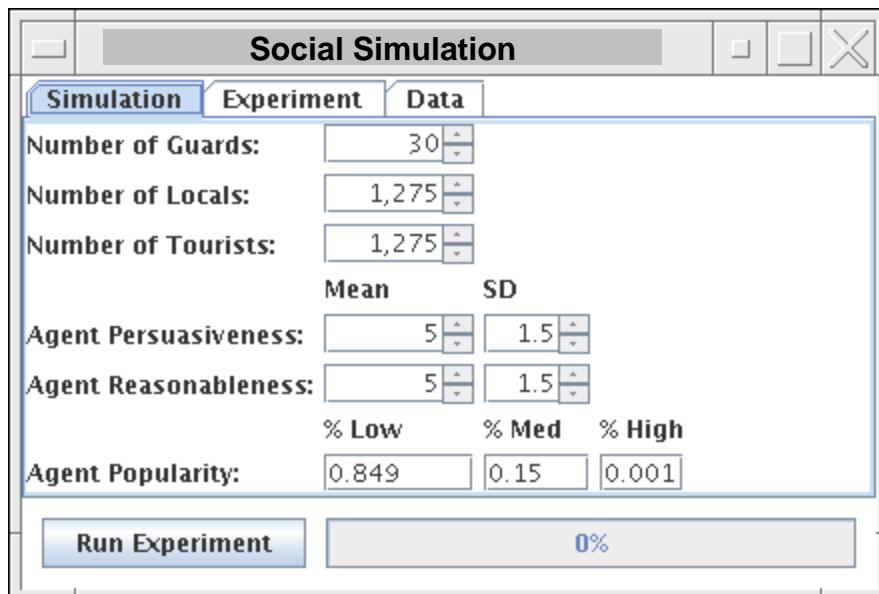


Figure 2: SocialSim Graphical Interface

The user can configure the interaction modes through the experiment tab pane in Figure 3. The interaction modes fall into three categories: Negative Guard Interaction, Agent Interaction, and Mixed Interaction. These interaction parameters are probability distributions that are used to choose the interaction types between the agent populations. The Negative Guard Interaction parameter specifies the frequency of negative interaction for local and tourist agents. The agent interaction parameter specifies the frequency of how often agent of the same class interacts (e.g. tourist-tourist, and local-local). Finally the Mixed interaction parameter specifies how frequent different classes of agents interact.

**Social Simulation**

	Low	Medium	High
<b>Negative Guard Interaction Prob</b>	.25	.5	.75
<b>Agent Interaction Prob</b>	.10		.25
<b>Mixed Interaction Prob</b>	.25	.5	.75

**Run Experiment**      0%

Figure 3: Interaction specification for SocialSim

The data tab panes, shown in Figure 4, allows the user to configure the location of the input and output files of the SocialSim. The SocialSim works on a 30 day cycle, and every ten days it requires a new interaction file.

**Social Simulation**

<b>Interaction Rules:</b>	/local/PMRSIM/deploy/Interactions.xls	<b>Choose</b>
<b>Day 1 Input:</b>	/local/PMRSIM/deploy/day1.dat	<b>Choose</b>
<b>Day 11 Input:</b>	/local/PMRSIM/deploy/day11.dat	<b>Choose</b>
<b>Day 21 Input:</b>	/local/PMRSIM/deploy/day21.dat	<b>Choose</b>
<b>Output File:</b>	/local/PMRSIM/deploy/output.xls	

**Run Experiment**      0%

Figure 4: Data configuration of SocialSim

#### 2.3.4 SimDIS

Please refer to the SimDIS User Manual, which is included as documentation.

## **2.4 LabSim Run Procedures**

### **2.4.1 Site Layout Creator**

To run the Site Layout Creator start the ESRI ArcMap application. Under the File Open menu use the File Chooser to select the pmrf.mxd mapfile. Once the map file is loaded the user may edit the site according to ArcMap button control.

### **2.4.2 SpatialSim**

To run the SpatialSim executable, user must be in a cygwin command shell environment. If none is available, ensure that the cygwin.dll is placed within the SpatialSim executable file path. To start the SpatialSim executable, enter the following command at the command prompt:

```
%> spatialsim ..\data\pmrf_sim.xml
```

Please see the troubleshooting notes for SpatialSim in Section 3 if the command screen does not show the following output.

```
*****  
* Starting SpatialSim *  
* Press Ctrl-D to exit*  
*****
```

Upon completion, the simulation will output to the screen the following messages:

```
TimeManager::removeEntity() -> Removed Entity
```

Once the simulation run is completed several output files are generated in the directory specified in the XML scenario input.

### **2.4.3 SocialSim**

To run the SocialSim executable, a run.sh shell script and a run.bat script is provided to automate the execution.

### **2.4.4 SimDIS**

To run SimDIS, the use has obtained the application and license from NRL (<https://simdis.nrl.navy.mil/>). Before starting the SimDIS, ensure that all spatial simulation output for SimDIS has been converted to a FCT extension file. To convert a SimDIS ASI extension to a FCT file, please use the following command line executable:

```
%> convertASI2FCT.exe <name of file as argument>
```

SimDIS can be started by clicking on the SimDIS icon and using the File Import menu to select a FCT extension file. Another way to start SimDIS is to enter the name at the command line prompt in this format:

```
%> simdis8.exe <name of FCT file as argument>
```

## 3 Troubleshooting Notes

### 3.1 Site Layout Creator

ESRI ArcMap application will not display imagery or vector data file if data directory has changed. To correct this problem, start ArcMap and add the data back into each map



layer using the add data icon located on the toolbar.

### 3.2 SpatialSim

#### 3.2.1 Missing SpatialSim XML Scenario Input File

The following error will display on the command screen if an incorrect location to the XML scenario input file is passed as an input argument to spatialsim.exe:

```
PMRSimConfigManager::initialize() scenarioFile  
./pmrf_sim.xml  
Fatal Error at file "0x103cd778", line 0, column 0  
    Message: 0x103cd618
```

#### 3.2.2 Improper Scenario Input

The following error will display on the command screen if the XML scenario file is improperly created:

```
PMRSimConfigManager::initialize() scenarioFile  
./data/test_pmrf_sim.xml  
Fatal Error at file "0x10408008", line 129, column 4  
    Message: 0x10407fb0  
PMRSimConfigManager::initialize()  
PMRSimConfigManager::createEventManager()  
ERROR:PMRSimConfigManager::createDataManager->Invalid  
DOMElement
```

To ensure that the XML scenario input file is compliant to XML syntax please use Altova XML Spy or simply view the scenario input in Microsoft Internet Explorer. The offending error line will appear in the browser.

## 4 Appendix

### 4.1 Scenario Input File

(pmrf\_sim.xml)

```
<scenario run_id="1">  
  <init_param>  
    <scenario_name>PMRF DEMO</scenario_name>  
    <classification>UNCLASSIFIED</classification>  
    <ref_date format="YYYY">2006</ref_date>  
    <coordinate_system>LLA</coordinate_system>  
    <ref_location>
```

```

        <latitude units="degrees">21.9954</latitude>
        <longitude units="degrees">-159.752</longitude>
        <altitude units="meters">5</altitude>
    </ref_location>
    <simulation_seed>1141330523</simulation_seed>
    <gis_data>
        <!-- TODO: read DTED elevation data
        <layer id="1" type="dted">
            <coordinate type="bounding_box">
                <northwest> </northwest>
                <southeast> </southeast>
            </coordinate>
            <resolution>0</resolution>
            <path> </path>
        </layer>
        -->
        <layer id="1" name="mail deliverer path" type="mgraph">
            <path
file_name="mail_deliverer">C:/home/nton/Projects/PMRSim/data/gis/road_network/mail_delive
rer/mail_deliverer.shp</path>
            </layer>
            <layer id="2" name="normal mail deliverer path" type="mgraph">
                <path
file_name="n_mail_deliverer">C:/home/nton/Projects/PMRSim/data/gis/road_network/mail_deli
verer/n_mail_deliverer.shp</path>
                </layer>
                <layer id="3" name="surfer path" type="mgraph">
                    <path
file_name="surfer">C:/home/nton/Projects/PMRSim/data/gis/road_network/surfer/surfer.shp</
path>
                    </layer>
                    <layer id="4" name="normal surfer path" type="mgraph">
                        <path
file_name="n_surfer">C:/home/nton/Projects/PMRSim/data/gis/road_network/surfer/n_surfer.s
hp</path>
                        </layer>
                        <layer id="4" name="navy personnel path" type="mgraph">
                            <path
file_name="personnel">C:/home/nton/Projects/PMRSim/data/gis/road_network/navy_personnel/p
ersonnel.shp</path>
                            </layer>
                            <layer id="4" name="normal navy personnel path" type="mgraph">
                                <path
file_name="personnel">C:/home/nton/Projects/PMRSim/data/gis/road_network/navy_personnel/p
ersonnel.shp</path>
                                </layer>
                                <!-- deprecated 3/26/06
                                <layer id="5" name="hostile path" type="mgraph">
                                    <path>C:/home/nton/Projects/PMRSim/data/gis/hostile/hostile_route.shp</path>
                                    </layer>
                                    -->
                                    <layer id="6" name="facility layout" type="polyshape">
                                        <path
file_name="facility_layout">C:/home/nton/Projects/PMRSim/data/gis/facility_layout/facilit
y_layout.shp</path>
                                        </layer>
                                        <layer id="7" name="site boundary" type="polyshape">
                                            <path
file_name="site_boundary">C:/home/nton/Projects/PMRSim/data/gis/site_boundary/site_bounda
ry.shp</path>
                                            </layer>
                                            <layer id="8" name="guard route 1" type="mgraph">
                                                <path
file_name="guard_route1">C:/home/nton/Projects/PMRSim/data/gis/guard_route/guard_route1.s
hp</path>
                                                </layer>
                                                <layer id="9" name="guard route 2" type="mgraph">
                                                    <path
file_name="guard_route2">C:/home/nton/Projects/PMRSim/data/gis/guard_route/guard_route2.s
hp</path>

```

```

        </layer>
        <layer id="10" name="guard route 3" type="mgraph">
            <path
file_name="guard_route3">C:/home/nton/Projects/PMRSim/data/gis/guard_route/guard_route3.s
hp</path>
        </layer>
        <layer id="11" name="point sensor layout" type="pointshape">
            <path
file_name="PointSensorLayout2">C:/home/nton/Projects/PMRSim/data/gis/sensor_layout/layout
2/PointSensorLayout2.shp</path>
        </layer>
        <layer id="12" name="line sensor layout" type="lineshape">
            <path
file_name="LineSensorLayout1">C:/home/nton/Projects/PMRSim/data/gis/sensor_layout/layout1
/LineSensorLayout1.shp</path>
        </layer>
    </gis_data>
    <simdis_output>sim3.asi</simdis_output>
    <agent_sim_output>sim3.agt</agent_sim_output>
    <fusion_output>fusion3.asp</fusion_output>
    <simulation_seed_file>seed.out</simulation_seed_file>
</init_param>
<entity_list>
    <sensor_units>

        <sensor_param>C:/home/nton/Projects/PMRSim/data/sensor_param.xml</sensor_param>
            <map_layer>point sensor layout</map_layer>
            <map_layer>line sensor layout</map_layer>
        </sensor_units>
        <!-- deprecated
        <hostile_units>
            <simdis_property>
                <icon>x</icon>
                <color>red</color>
                <type>H</type>
                <fhn description="HOSTILE">H</fhn>
            </simdis_property>
            <population>0</population>
            <attack_time units="seconds">
                <min>240</min>
                <max>1200</max>
            </attack_time>
            <map_layer>facility layout</map_layer>
            <map_layer>hostile path</map_layer>
        </hostile_units>
        -->
        <visitor_units>
            <population>
                <general_type>
                    <type name="tourist" percent=".20"/>
                    <type name="local" percent=".80"/>
                </general_type>
                <class name="surfer" code="S" size="25">
                    <map_layer>surfer path</map_layer>
                    <visit_hours units="seconds">
                        <peak>43200</peak>
                        <variance>7200</variance>
                        <cutoff>61200</cutoff>
                        <leave>14400</leave>
                    </visit_hours>
                    <simdis_property>
                        <icon>O</icon>
                        <color>yellow</color>
                        <type>V</type>
                        <fhn description="FRIENDLY">F</fhn>
                    </simdis_property>
                </class>
                <class name="mail deliverer" code="M" size="5">
                    <map_layer>mail deliverer path</map_layer>

```

```

        <visit_hours units="seconds">
            <peak>43200</peak>
            <variance>7200</variance>
            <cutoff>61200</cutoff>
            <leave>14400</leave>
        </visit_hours>
        <simdis_property>
            <icon>x</icon>
            <color>yellow</color>
            <type>V</type>
            <fhn description="FRIENDLY">F</fhn>
        </simdis_property>
    </class>
    <!-- TODO
    <class name="fisher men" code="F" size="10">
        <map_layer>fishermen path</map_layer>
        <visit_hours units="seconds">
            <peak>43200</peak>
            <variance>7200</variance>
            <cutoff>61200</cutoff>
            <leave>14400</leave>
        </visit_hours>
    </class>
    -->
    <class name="navy personnel" code="NP" size="100">
        <map_layer>navy personnel path</map_layer>
        <visit_hours units="seconds">
            <peak>43200</peak>
            <variance>7200</variance>
            <cutoff>61200</cutoff>
            <leave>14400</leave>
        </visit_hours>
        <simdis_property>
            <icon>O</icon>
            <color>blue</color>
            <type>V</type>
            <fhn description="FRIENDLY">F</fhn>
        </simdis_property>
    </class>
    <!--
    <class name="civilian" code="CV" percent="800">
        <map_layer>civilian</map_layer>
        <visit_hours units="seconds">
            <peak>43200</peak>
            <variance>7200</variance>
            <cutoff>61200</cutoff>
            <leave>14400</leave>
        </visit_hours>
    </class>
    -->
    </population>
    <map_layer>facility layout</map_layer>
</visitor_units>

<guard_units>
    <population>9</population>
    <simdis_property>
        <icon>O</icon>
        <color>green</color>
        <type>G</type>
        <fhn description="FRIENDLY">F</fhn>
    </simdis_property>
    <shift name="night">
        <start_time>0</start_time>
        <end_time>28800</end_time>
    </shift>
    <shift name="morning">
        <start_time>28800</start_time>
        <end_time>57600</end_time>
    </shift>
    <shift name="night">

```

```

        <start_time>57600</start_time>
        <end_time>86400</end_time>
    </shift>
    <map_layer>guard route 1</map_layer>
    <map_layer>guard route 2</map_layer>
    <map_layer>guard route 3</map_layer>
    <surveillance>
        <stop_frequency>.2</stop_frequency>
        <stop_interval unit="seconds">300</stop_interval>
        <detection_distance>100</detection_distance>
    </surveillance>
</guard_units>

<rapid_reaction_units>
    <simdis_property>
        <icon>0</icon>
        <color>yellow</color>
        <type>R</type>
        <fhn description="FRIENDLY">F</fhn>
    </simdis_property>
    <population>0</population>
    <map_layer>rrf station</map_layer>
    <response_delay units="seconds">120</response_delay>
    <detection_distance>10</detection_distance>
</rapid_reaction_units>

</entity_list>

<anomaly_detector>
    <normalcy_data class="mail deliverer">
        <map_layer>normal mail deliverer path</map_layer>
    </normalcy_data>
    <normalcy_data class="surfer">
        <map_layer>normal surfer path</map_layer>
    </normalcy_data>
    <normalcy_data class="navy personnel">
        <map_layer>normal navy personnel path</map_layer>
    </normalcy_data>
    <error_tolerance threatcon="ALPHA">20</error_tolerance>
    <anomaly_file>c:/home/nton/Projects/PMRSim/bin/test.csv</anomaly_file>
</anomaly_detector>
<data_mgr>
    <classes>C:/home/nton/Projects/PMRSim/data/classes.xml</classes>
</data_mgr>
<time_mgr>
    <start_time units="seconds">0</start_time>
    <end_time units="seconds">86400</end_time>
</time_mgr>
</scenario>

```